WHY DO YOU NEED AN AIR PRESSURE CONTROLLER DURING TUBING EXTRUSION?

Stable, precise, constant, low pressure for extruding plastic tubes.

Written by Kay DeWolfe

On Line Controls Inc

The Importance of controlling Internal Air Pressure During Tubing Extrusion

During the tubing extrusion process, it is important to control of internal air pressure to hold the OD, ID, ovality, sizing, structure and shape of the plastic profile. Although in many extrusion articles it is listed as air support and not a critical component, it can be one of the most important pieces of equipment on the line.

TYPES OF TUBING AND PROFILES

- single lumen
- catheters,
- multi-lumen,
- bump tubing,
- co-extrusions,
- tri-layer extrusions,
- micro-extrusion,
- balloon tubing,
- profile extrusions,
- taper tubing;
- Thin-wall,
- Heat shrink,
- medical tubing,
- drinking straws,
- thicker-walled dilators, and
- automotive tubing

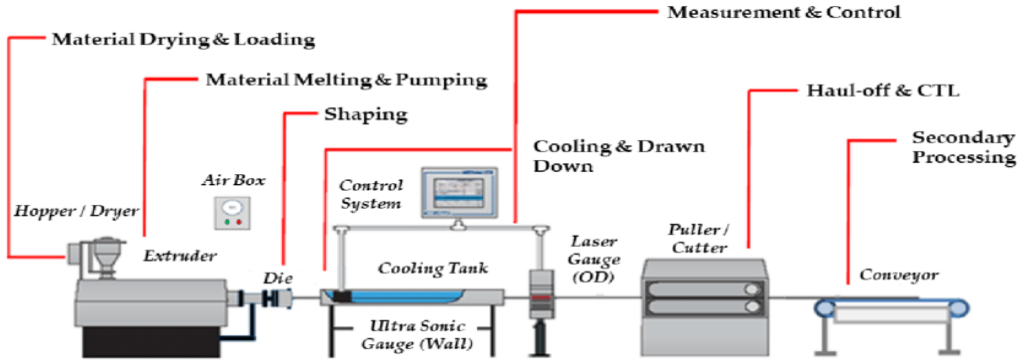
Controlling the internal air pressure is an integral part of the tubing extrusion process. Used for two reasons, sizing and structure in some of the smallest and most complex, with the tightest tolerances tubing in the industry.

The Tubing Extrusion Process

The process of tubing extrusion is used to manufacture products like medical tubing and drinking straws. The plastic extrusion process is highly customizable and is capable of high-volume production as well as short runs, making plastic extrusion one of the most versatile and economical methods of plastic fabrication. The process uses a continuous output of smooth, thoroughly heated and mixed material, extruded plastics seldom have bubbles or inconsistencies, and they are therefore valued for their structural integrity and consistent profiles.

Extrusion is a continuous process by which the extruder mixes, melts, and meters the plastic. The extrusion process begins with raw plastic pellets or flakes being fed into a hopper. From the hopper the raw plastic material goes into the extruder channel where it is feed through a screw in the extruder pushing it to the opposite end, while shearing and heating the plastic. When the plastic becomes molten, it is fed through a die which shapes the plastic. To extrude the hollow sections, a pin or mandrel is placed inside the die and positive pressure is applied through the pin onto the internal cavities. Additional lumens or holes may be introduced by adding the appropriate inner mandrels to the die. It is then cooled and pulled through a series of conveyors and cut to appropriate lengths or spooled. Draw down control sizing technology (free extrusion) where the extruded tubular melt has no calibrating device after leaving the die. It could have internal air pressure so that the tube does not collapse upon leaving the die. Devices are also used with different designed calibrating/sizing plates or tubes with or without pressure or vacuum assist in and/or outside the tube.

If you extrude tubing, you know that maintaining precise process conditions is often an operational imperative. Maintaining the desired internal pressure requires a precision regulator.



Air Control is a critical need in most tubing extrusion lines.

The Role of Air in Extrusion

Small plastic tubing is can be extruded into air or a vacuum tank, and after being drawn down close to the final size, into a water bath. A constant stream of air, injected via the die into the tubing is required to prevent the collapse of the partially molten tube, keep it round, and to control the diameter. A stable dimeter depends on maintaining a constant pressure even when varying flow rates of air through the tubing.

During the free extrusion process, air at a specific pressure is used to obtain the intended tubing shape. The goal is that by controlling the extrusion rate along with the internal air pressure of the tubing you can achieve the correct values for the outside diameter and wall thickness. Low air pressure is injected into the DIE which flows through the center of the pin that makes up the inner part of the extrusion die, and then directly into the semi-fluid tubing as it is coming out of the die. Sizeable diameter variations can be caused by the slightest pressure change during the extrusion of thin-walled products. If the air pressure is not constant, the extruded tube wall section will vary. A needle valve can control pressure only if the flow is constant. Since the flow varies, a true pressure regulator is needed to maintain the required tubing dimensions. Thereby automatically keeping the diameter within tolerance by using the support pressure.

Air Pressure with Vacuum Support

Vacuum cooling tanks can expose the external surface of the extruded pipe or tube to vacuum, so that the differential air pressure inside the tube or pipe maintains outward pressure on the sizing tooling the outward pressure ensures that the finished product has a proper ID and OD. Differential air pressure is used to shape the interior of the tube. Pressure and vacuum are combined to hold thin layers of tubing from collapsing. Even with vacuum control each lumen in multi-lumen tubing must have a separately regulated source of air pressure.

PURPOSE

The main function of an ULTRA LOW AIR PRESSURE REGULATOR is to supply stable easily-regulated differential air pressure from your normal air source, to shape the interior of the tube. Air-supply unit's control of the tubing must provide precise pressure regulation to ensure close tubing dimensional tolerances are kept. Typically, the pressure regulation is +/- 0.01%. Sizeable diameter variations can be caused by the slightest pressure change during the extrusion process. Air pressure control is most often the best variable to control because it directly affects I.D. and O.D., and does not affect any part of the extrusion process that is sensitive to speed changes such as in line length-cutting, saws or wind-up. Mike Ferrandino explains:"

SIZING THE TUBING

- Air Pressure is used to increase or decrease the inner diameter/s of tubing being extruded.
- Increasing the air pressure/volume supplied to a lumen
  + will increase the diameter of that lumen
  + will make the wall of the structure surrounding the affected lumen a tad thinner

  (provided extruder output and line speed stay the same)
- Decreasing the air pressure supplied to a lumen
  + will reduce the diameter of that lumen
  + increase the wall thickness, around the lumen"

Air Pressure regulators have become more precise and stable over the years, from the very simple regulator/manometer, manually adjustable units to the more sophisticated taper tube offerings. Manual air support regulators are still used in many straight single lumen medical, automotive and other industries.

O.D Gauges or laser gauges can control the air pressure using contact closures to connect them. Units can be controlled by push buttons on the front or your OD gauges or laser gauges by contact closures.

High speed switching between pressures can be done with 0-10 volt input controller, especially for bump or taper tubing. This technology can transition between 2 set points much smoother.

"When free extruding a tube, the internal air is critical to maintaining precision diameter control. Always advise processors to use as little air as possible as air is compressible and thus can cause diameter fluctuation. If more than 1" is needed I always recommend the die should be changed to enhance precision and ease of processing. Less internal air means that cutting and coiling will have less affect on dimensional control. The incoming air to the precision air regulator should have one or more air regulators and even a flow control to minimize shop air variations potential to affect the precision air regulation." Bob Bessemer of Novatec

AIR PRESSURE REGULATORS

By providing the air support inside the tube during extrusion, our "MicroAir" can maintain the tubing's shape, size, ovality, and prevent the collapse of the tube even when it is cut or coiled.

On Line Controls MODELS:

- **MicroAir I**, regulator, manual model
- **MicroAir II**, controller accepts contact closure up/down inputs or uses 2-speed push buttons for manual control.
- **MicroAir IV**, controller with 0-10 volt input which can connect to a PLC or line controller and can-do high-speed switching for bump and taper tubing. For bump or tapered profile tubing, the ID air pressure cannot simply be held constant. Rather, pressure must be ramped up and down in a controlled manner as the OD changes, so as to maintain the relative dimensions between the various lumens.

Offered in Single, Dual and 3- channel MicroAir I and II models; and
Single, Dual, 3-channel, and 4-channel MicroAir IV units for Multi-Lumen tubing.

Options for MicroAir II and IV: Digital Display (bright LED);
Output options (0-10 volt or 4-20 ma),
Remote, and Stand

ULTRA LOW RANGES

The air pressure required during tubing extrusion can be as low as 0.5” of water. Most medical tubing uses 0-15” of water, 0-30” of water (0-1 psi) or lower.

Our MicroAirs are reliable, stable, precise and can hold pressures down below 1” of water (0.036 psi) using our 0-2” of water or 0-3” of water range. Meters are available in “inches of water”, mbar, kpa and psi. Maximum pressure range is 0 – 5 psi.
It is recommended the pressure required on the tubing extrusion line be in the middle of the range/meter on your MicroAir unit.

Most Common Ranges for Medical Tubing are:

0-3 inches of water, 0-5 inches of water, 0-15” of water, 0-30” of water

Other Ranges used for larger or automotive tubing include:
0-50” of water, 0-80” of water, 0-3 psi and 0-5 psi

“The On Line Controls MicroAirs are by far the most common unit used for medical tubing processing with great industry acceptance. And with the new low range units the regulation is extremely precise with great resolution capabilities.” Bob Bessemer

Conclusion

Ultra low air pressure regulation is one of the more important critical parameters that must be controlled on a plastic tubing extrusion line. Product O.D. is a direct function of air pressure and product uniformity requires the ability to depend upon ultra low air pressure regulation. For true O.D./I.D. control, both line speed (i.e. screw or haul off) and air pressure must be controlled.

Demands for medical tubing to be smaller and tighter dimensions, have driven tubing diameters with thinner walls, higher tolerances and strength, make holding the inner diameter critical.

Please be sure to send any questions, or comments to kdewolfe@onlinecontrols.com.

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"You guys make great products." Matt Mandeville

"The gold standard in air control for medical extrusion."
Mike Ferrandino